LA-UR-19-20091
Approved for public release; distribution is unlimited.

| | |
|---|---|
| Title: | Los Alamos National Laboratory Opportunities for Students |
| Author(s): | Cleveland, Mathew Allen |
| Intended for: | Recruiting Presentation |
| Issued: | 2019-01-09 |

# Los Alamos National Laboratory Opportunities for Students

**Mathew Cleveland, CCS-2**
**Los Alamos National Laboratory**

January, 2019

# Early History of Los Alamos and the National Laboratory

Native Americans lived on the Pajarito plateau hundreds of years.

Los Alamos was the site of a Boys Ranch School, est. in 1917.

During WW2 it was chosen as the site for a Laboratory in the Manhattan Project.

In 1942 work began to establish the Laboratory. Los Alamos became a 'secret city'.

*Los Alamos Ranch School students and teachers playing ice hockey in shorts*

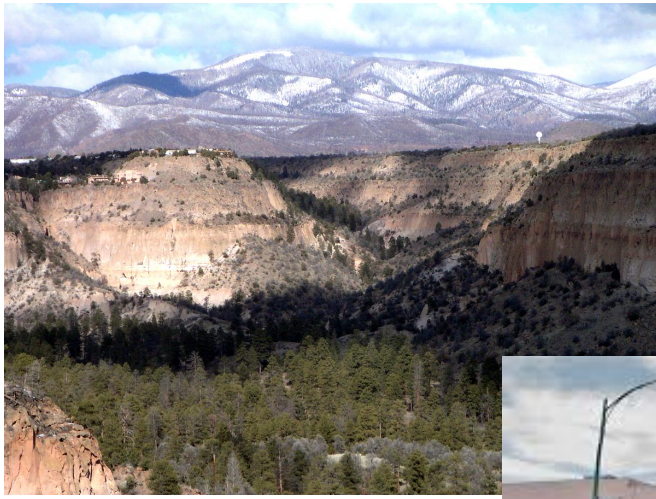
Ashley Pond

The main gate


Tech Area-1

H. Bethe and E. Fermi

# Los Alamos Today



# Outdoors and Attractions

- Bandelier National Monument
- Jemez Mountains
- Valles Caldera National Preserve
- Los Alamos Ski Area
- Sangre De Christo Mountains
- Santa Fe, Taos, Spanish heritage
- Native culture, Pueblos






# Los Alamos National Laboratory - People, Location

- Covering 43 square miles on the Pajarito Plateau in Northern New Mexico
- This is about the area of Washington D.C.
- About 10,000 employees, about ¼ are Ph.D. researchers
- There are about 350 postdocs
- In the summer there are about 1,200 students (high school, undergraduate, and graduate)
- Annual budget of > 2 billion dollars
- Currently run by Triad National Security, a nonprofit formed by Battelle Memorial Institute, The Texas A&M University System, and the University of California

# The National Laboratories are FFRDCs

## Federally Funded Research and Development Centers


FFRDCs are public-private partnerships which conduct research for the United States Government. There are currently 42 of them.

# DOE National Laboratories

**There are 17 DOE National Laboratories, grouped in three categories.**

- **DOE Office of Science:**
  - AMES Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Fermi National Accelerator Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Princeton Plasma Physics Laboratory, SLAC National Accelerator Laboratory, Thomas Jefferson National Laboratory

- **National Nuclear Security Administration**
  - Lawrence Livermore National Laboratory, **Los Alamos National Laboratory**, Sandia National Laboratories

- **Other**
  - Idaho National Laboratory, National Energy Technology Laboratory, National Renewable Energy Laboratory, Savannah River National Laboratory

# DOE Office of Science and NNSA

**Office of Science**

The Office of Science's (SC) mission is to deliver scientific discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic, and national security of the United States. SC is the Nation's largest Federal sponsor of basic research in the physical sciences and the lead Federal agency supporting fundamental scientific research for our Nation's energy future. (https://science.energy.gov)

**National Nuclear Security Administration**

Established by Congress in 2000, NNSA is a semi-autonomous agency within the U.S. Department of Energy responsible for enhancing national security through the military application of nuclear science. NNSA maintains and enhances the safety, security, and effectiveness of the U.S. nuclear weapons stockpile without nuclear testing; works to reduce the global danger from weapons of mass destruction; provides the U.S. Navy with safe and effective nuclear propulsion; and responds to nuclear and radiological emergencies in the U.S. and abroad. (https://nnsa.energy.gov)

# Los Alamos National Laboratory – Science Mission

**Our science mission is organized into four pillars:**

- **Information Science and Technology** - leverages advances in theory, algorithms, and the exponential growth of high-performance computing to accelerate the integrative and predictive capability of the scientific method.
- **Materials for the Future -** seeks to optimize materials for national security applications by predicting and controlling their performance and functionality through discovery science and engineering.
- **Nuclear and Particle Futures** - applies science and technology to intransigent problems of system identification and characterization in areas of global security, nuclear defense, energy, and health.
- **Science of Signatures** - integrates nuclear experiments, theory, and simulation to understand and engineer complex nuclear phenomena.

# A Snap Shot of Research From My Group -

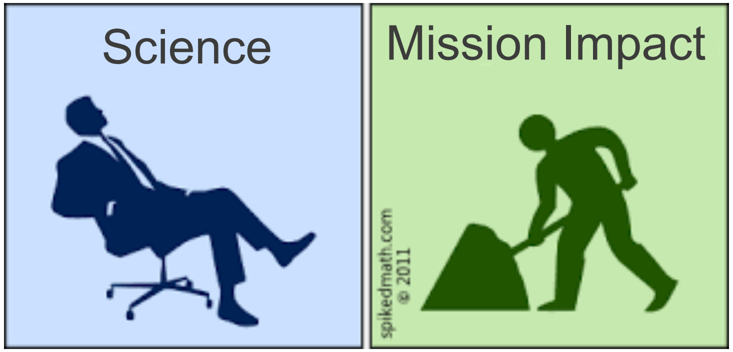
# Computational Physics and Methods (CCS-2)

# Computational Physics and Methods Group, CCS-2

**“Performing innovative simulations of physics phenomena on tomorrow's scientific computing platforms”**

- CCS Division was formed to strengthen the visibility and impact of computer science and computational physics research on strategic directions for the Laboratory.
- Both computer science and computational science are now central to scientific discovery and innovation. They have become indispensable tools for all other scientific missions at the Laboratory.
- CCS Division forms a bridge between external partners and Laboratory programs, bringing new ideas and technologies to bear on today’s important problems and attracting high-quality technical staff members to the Laboratory.
- **The Computational Physics and Methods Group CCS-2 conducts methods research and develops scientific software aimed at the latest and emerging HPC systems.**

# Computational Physics and Methods Group, CCS-2




*People*

- 42 Scientists
- 17 Postdocs
- ~25 students, most in summer
- 2 scientist/managers
- 1 admin

*Education*

- Physics
- Engineering (Nuclear, Aerospace, Mechanical)
- Climate Science
- Astrophysics
- Applied Mathematics

**Budget: ~$25 million/year**

*Academic Activities*

- Publishing – in FY16 ~80 peer reviewed publications by people in CCS-2
- Several staff serve on editorial boards
- Service on review panels
- Several staff are fellows of their academic associations (AIAA, ANS, APS)

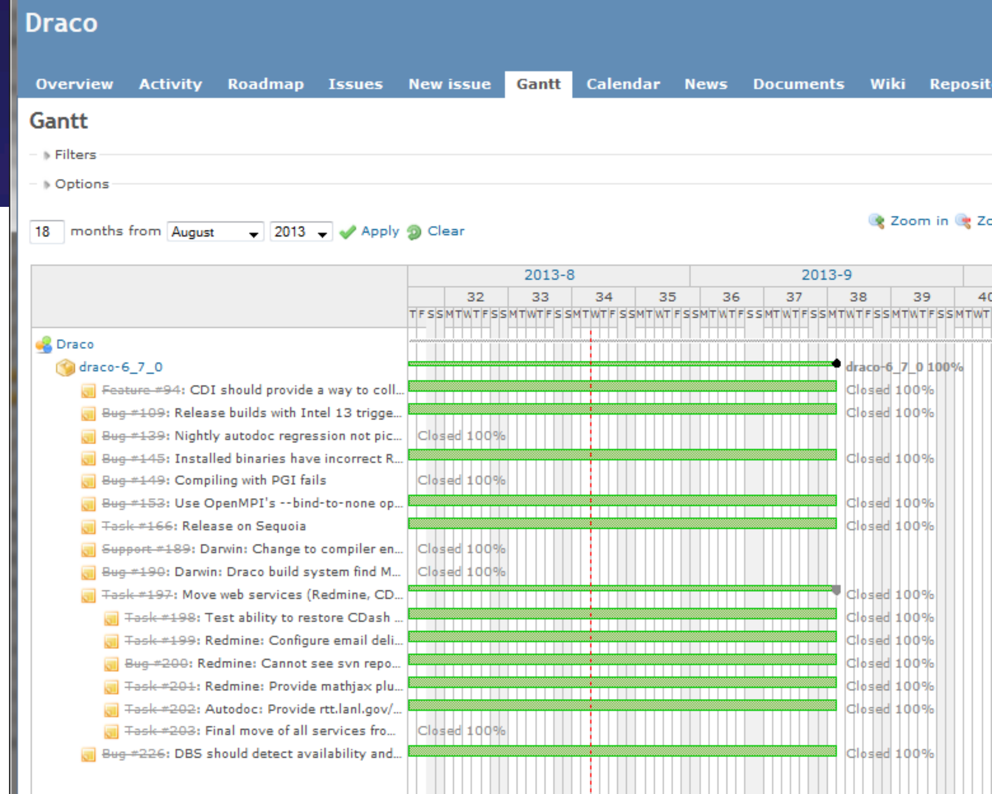
as of October 2017

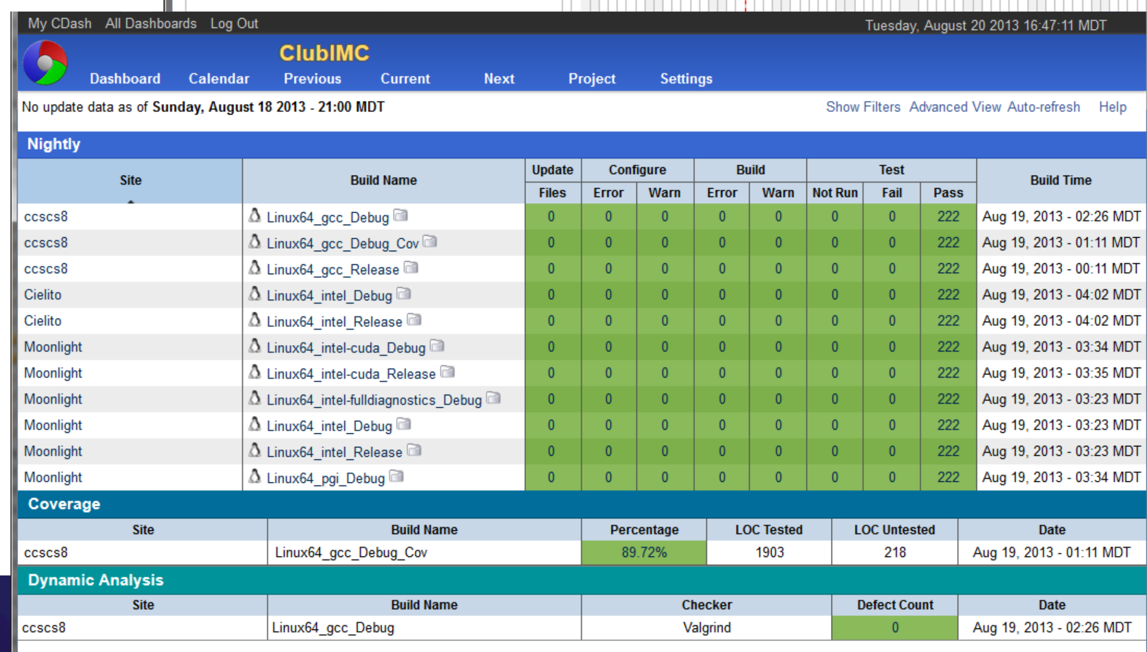
# Highly Parallel Scientific Production Software

- **All staff and postdocs in CCS-2 develop code that must run at scale**
- **Our codes/libraries run on the largest computers in the country**
- **Many/most of our codes/libraries**
  - Are highly parallel (MPI)
  - Leverage accelerators (KNL, GPU, …)
- **Code teams utilize various levels of SQA**
  - Version control
  - Continuous testing
  - Code reviews
  - Documentation
- **We program in many languages and paradigms**
  - C, C++, Fortran (various versions), python
  - Charm++, Legion, MPI, MPI+X, CUDA, OpenMP, OpenACC, …

# Software Management

- **Software Design**
  - C++ Object-Oriented design
  - Package management
  - Profiling
- **Build systems**
  - Workstations, Unique Systems, Heterogeneous
  - Vendor management
- **Testing**
  - Unit testing
  - Regression testing
  - Memory testing & Code Coverage
- **Dashboards**
- **Documentation**
- **Releases**



# Flavors of Work/Funding in CCS-2

- **Science based stockpile stewardship**

  "The SSP combines nonnuclear experiments, highly accurate physics modeling, and improved computational power to simulate and predict nuclear weapon performance over a wide range of conditions and scenarios. This predictive power affords NNSA and the weapons laboratories the necessary tools to assess the stockpile, maintain its performance, continuously improve safety, respond to technological surprise and support future treaties." (from the NNSA website)

- **Office of Science**
  - Biological and Environmental Science (BER)
  - Exascale Computing Project (ECP)
  - Advanced Scientific Computing Research (ASCR)

- **Internal Research Competition and Program Development**
  - Laboratory Directed Research and Development - Exploratory and Directed
  - Pathfinder

- **Work for Others**
  - Industry

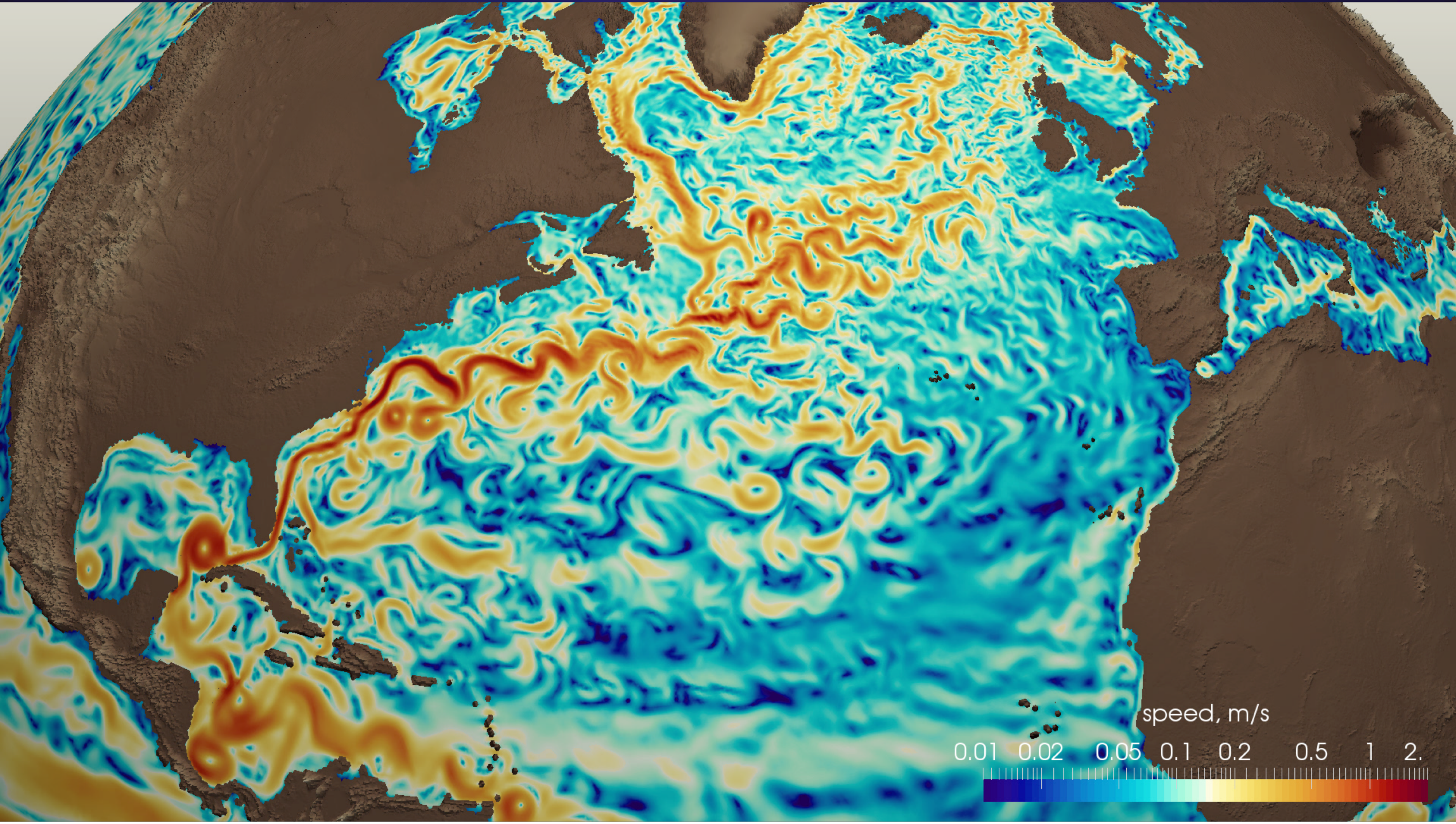
# Climate Science

# Accelerated Climate Model for Energy


- New coupled climate model by the U.S. Department of Energy
- 120 DOE employees on effort
- Goals:
  - Risk assessment and planning related to climate and extreme weather.
  - Address mission-specific applications from U.S. energy sector vulnerabilities
  - Sea level rise, Antarctic ice sheet instabilities
  - Efficiently utilize DOE leadership computing resources

Point of Contact: Mark Petersen, CCS-2/LANL

# Gulf Stream

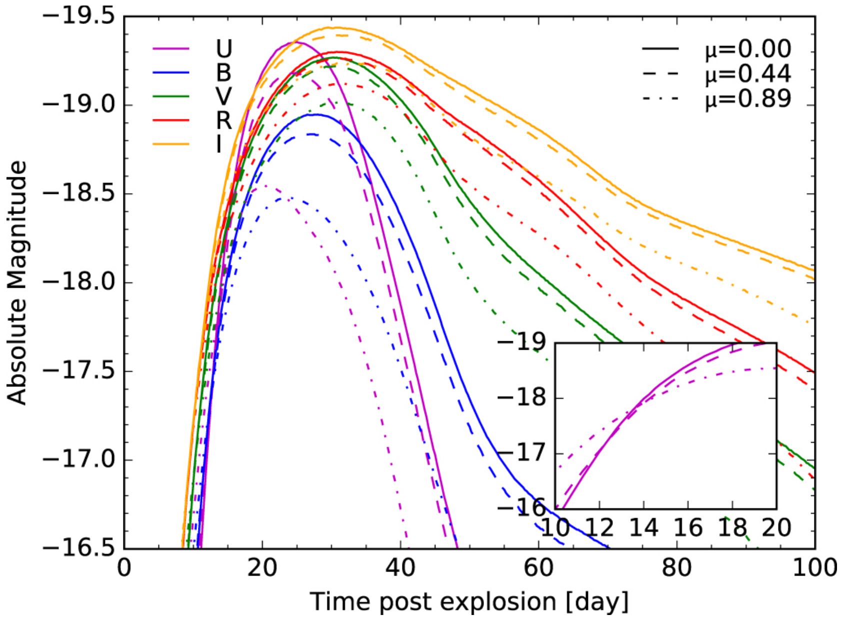



Point of Contact: Mark Petersen, CCS-2/LANL

# Astrophysics

# SuperNu

SuperNU is a parallel code that our former postdoc and now staff-scientist Ryan Wolleager wrote and still develops.



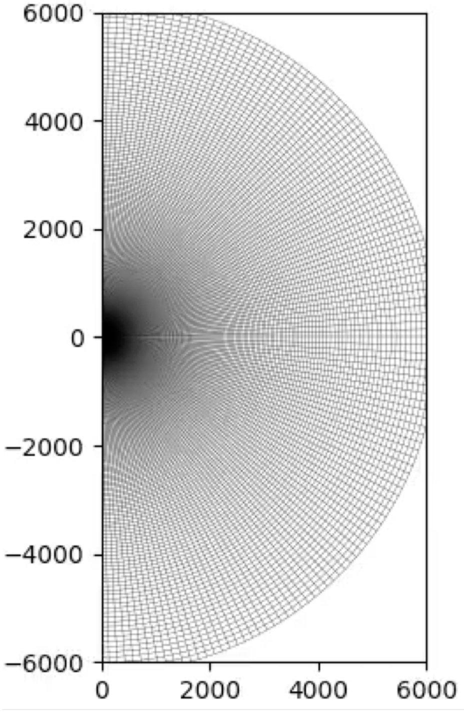

- **SuperNU solves radiative transfer in supernovae, for light curves and spectra.**
  - Results can be compared to observations.
- **Typical time scales simulated are days to months**

- Light curves for different viewing angles of a White Dwarf merger (van Rossum et al (2016))

# The Fornax Supernova Code

- **1-D, 2-D, 3-D neutrino radiation hydrodynamics**
- **Metric-based formalism makes it "easy" to change geometries and coordinates**
- **Dendritic mesh avoids severe CFL limit at small radii**
- **Geometrically correct parabolic reconstruction**
- **3-species, multi-group M1 transport**
- **All O(v/c) terms included**
- **Multipole gravity**
- **"Relativistic corrections" for monopole gravity, and transport (e.g. redshifts)**
- **Support for complex, tabulated equations of state**
- **Fast and highly scalable**
  - 2D CCSN simulations in ~2-3 days
  - 3D shows **excellent** *strong* scaling

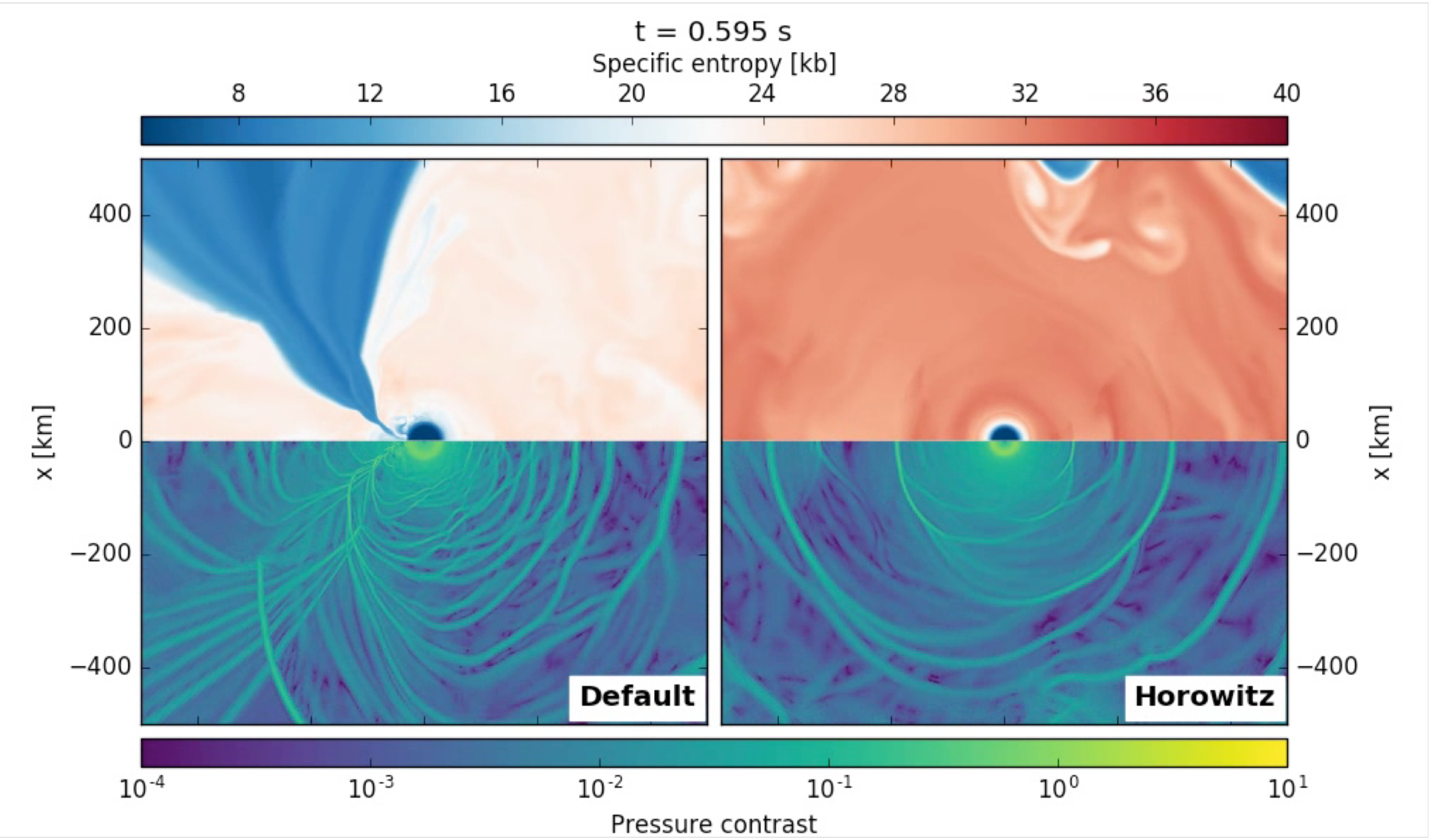
Fornax and eblight were developed/co-developed by our former postdoc and now staff-scientist Joshua Dolence.




Point of Contact: Joshua Dolence, CCS-2/LANL

# The Fornax Supernova Code

Fornax is used primarily to understand how massive stars explode

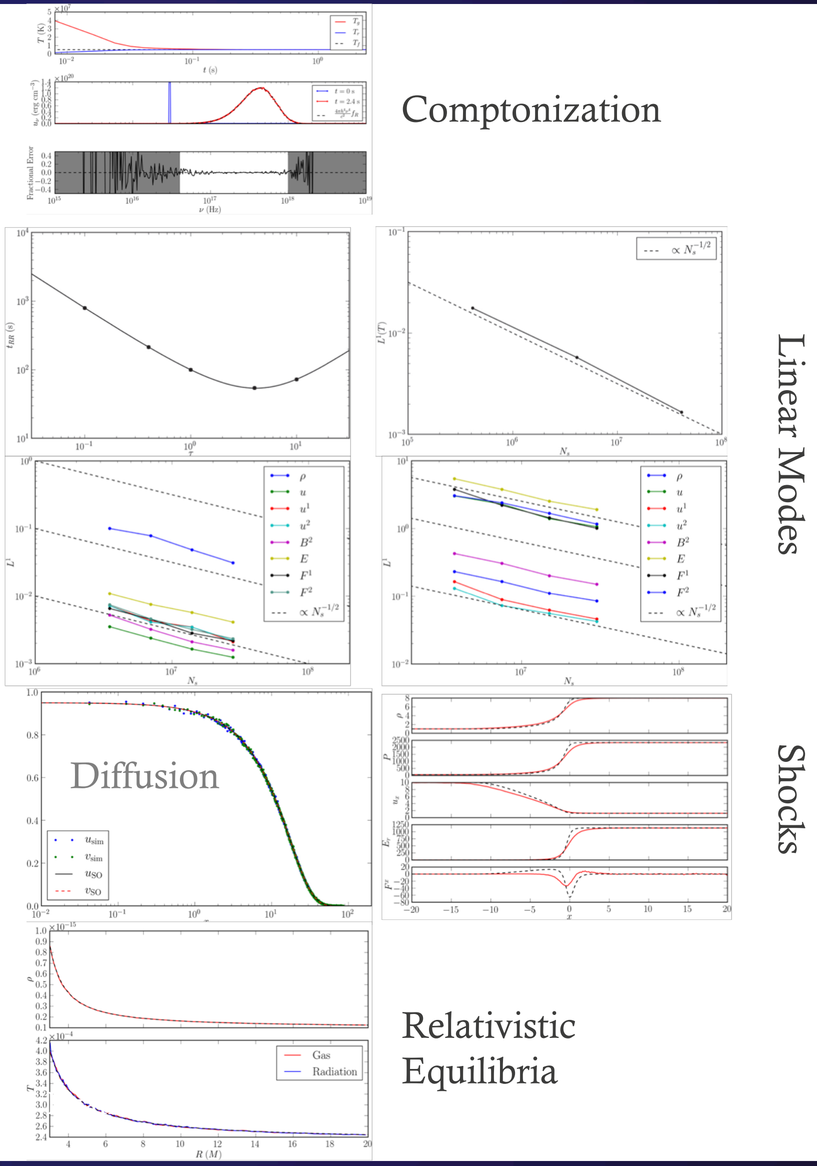



Default vs. Horriwitz: Difference in neutrino opacities

Point of Contact: Joshua Dolence, CCS-2/LANL

# ebhlight: General Relativistic Radiation MHD with Monte Carlo Transport and Electron Thermodynamics

- **Ideal GRMHD**
- **Full solutions of the relativistic transport equation --- no ad hoc or approximate closures**
- **Anisotropic emission and scattering**
- **Inelastic (Compton) scattering**
- **Separate evolution of ion and electron thermodynamics with input from detailed plasma physics models**
- **Conservative coupling**
- **Limitations: Monte Carlo noise and stiff source terms**

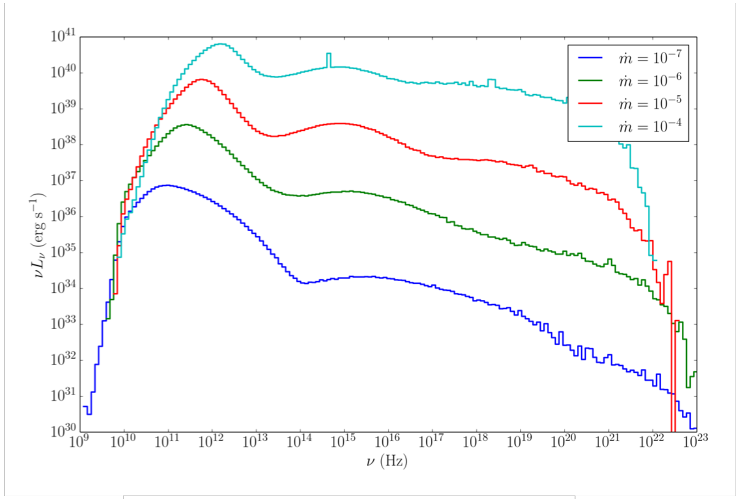


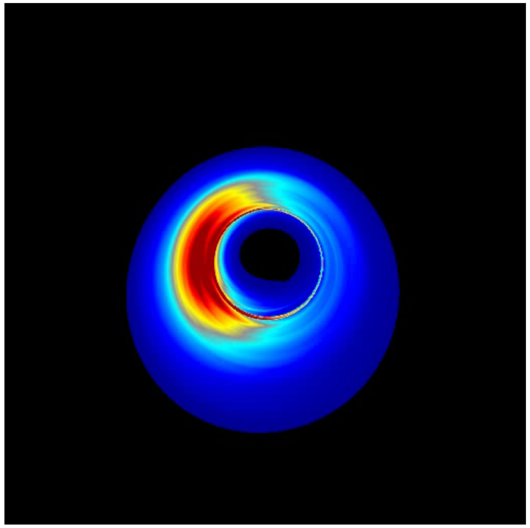

Point of Contact: Joshua Dolence, CCS-2/LANL

# ebhlight studies the dynamics of radiating MHD flows around black holes

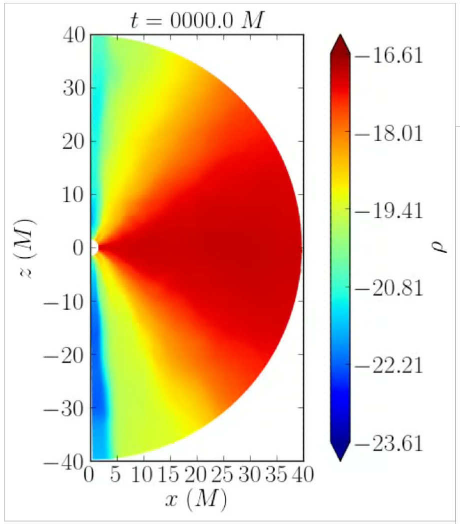
Results can be compared with observations…(→event horizon telescope)

Simulated spectra

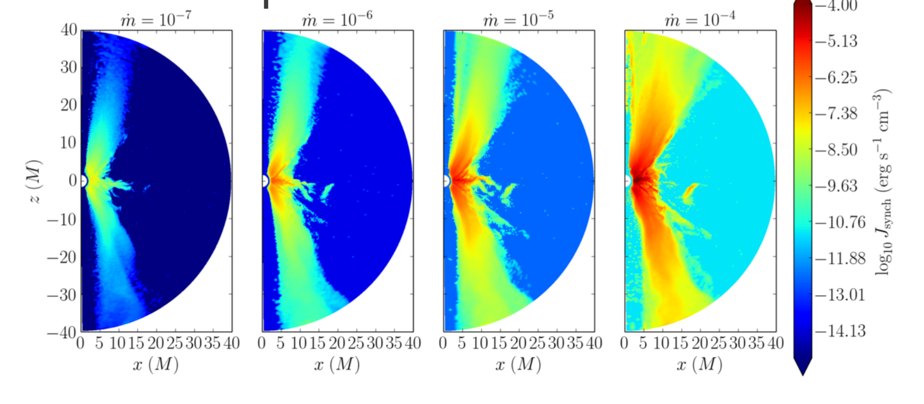


Simulated images




…and used to facilitate interpretation



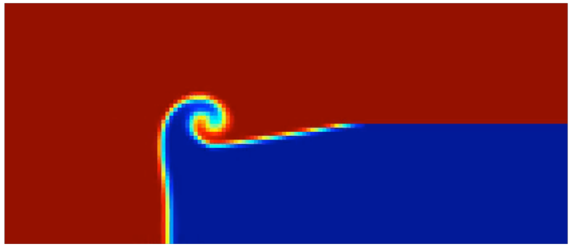

Point of Contact: Joshua Dolence, CCS-2/LANL

# xRage – A Large-Scale Multi-Physics Hydro Code

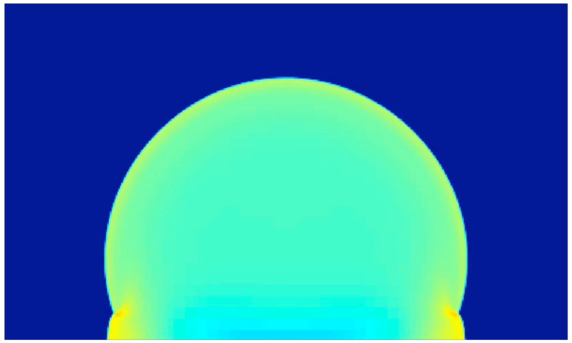
- **xRAGE is a multi-material, multi-physics Eulerian AMR code**
- **Application Areas: Inertial Confinement Fusion, Astrophysics**
- **Problem Size: Up to… many billions of cells in computational domain, multiples of 10,000 processors, multiple weeks of simulation time**
- **xRage employs finite volume discretizations with mostly explicit time-integration for conservative-by-construction algorithms**
- **Some reliance on third-party libraries, mostly for numerical linear algebra (e.g. HYPRE, Trilinos); also, interpolators and ODE integrators**

*LANL's xRAGE code is being developed by the ASC Eulerian Applications Project (Leads: Joann Campbell XCP-2, Galen Shipman CCS-7)*

Triple point problem



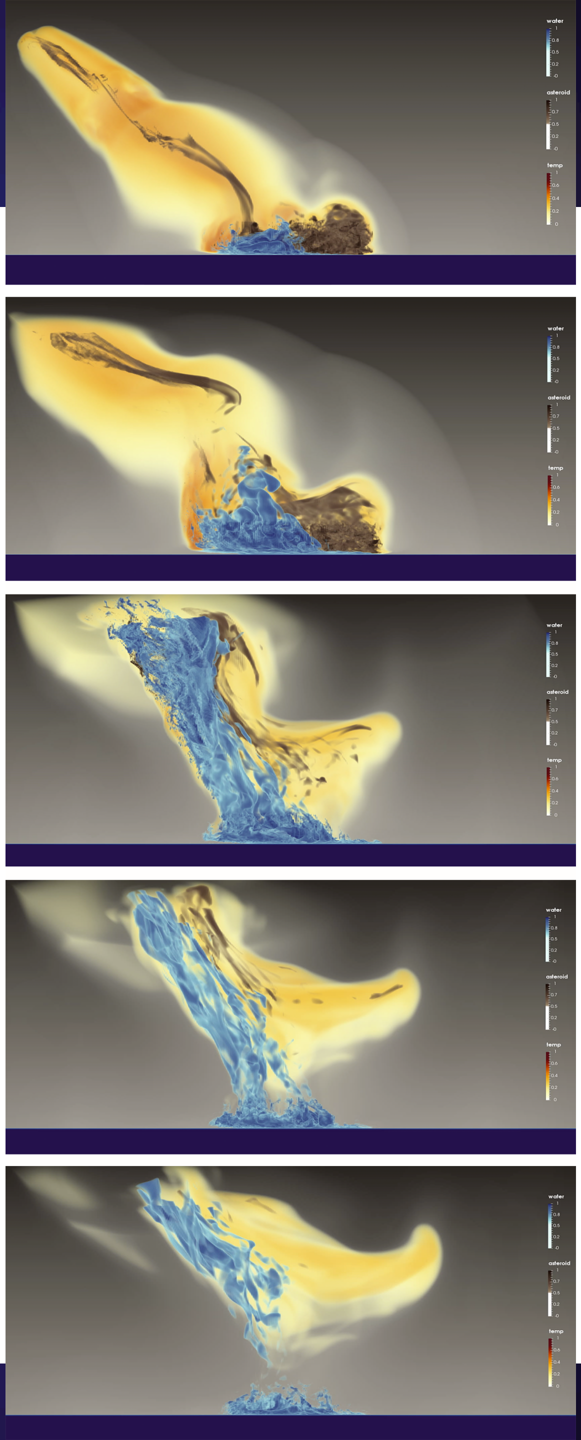
Ground interacting blast



CCS-2 Point of Contact: Joshua Dolence, CCS-2/LANL

# xRage – all the physics

- **Multi-dimensional hydrodynamics (inviscid Euler Equations)**
- **Material interface reconstructions**
- **Constitutive models (Equations of State, Strength models)**
- **Cell-based Adaptive Mesh Refinement (AMR)**
- **Grey radiation diffusion**
- **Heat conduction**
- **Plasma physics (electron, ion heat conduction, electron-ion coupling)**
- **Lasers (ray-tracing)**
- **Isotopes**
- **Thermonuclear burn**
- **Engineering Turbulence Models**
- **Gravity (uni-directional, and self-gravity)**
- **High Explosives models**



xRage asteroid Impact calculation –
visualization by John Patchet, CCS-7/LANL

CCS-2 Point of Contact: Joshua Dolence, CCS-2/LANL

# Computational Fluid Dynamics

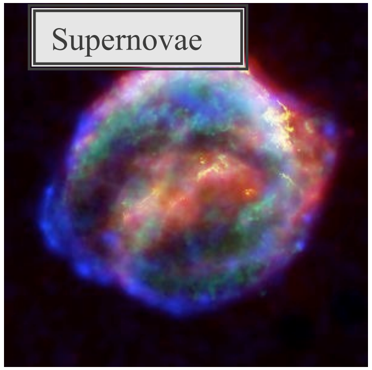
# CFDNS is a petascale code framework for Direct Numerical Simulations of fluid turbulence

## BACKGROUND & MOTIVATION

- Almost all fluid systems of practical relevance have some turbulence component.
- Yet after decades of research, turbulence and turbulent mixing still remain unsolved problems in physics; this due in part to the very large range of spatio-temporal, dynamically relevant scales.

Examples of instabilities driven turbulence from small to large size systems






## DESCRIPTION

- Large scale computing is beginning to allow accurate simulations of ever more complex turbulent flows at practically relevant parameter ranges.
- Such simulations (called DNS), using higher order methods and resolving all the dynamically relevant scales, without subgrid modeling, artificial dissipation or other numerical stabilization algorithms, complement physical experiments in elucidating the physics of the flow and providing data for the development of turbulence models.

➢ Unlike the physical experiments, there is a complete control of the initial and boundary conditions as well as measuring quantities of interest.

➢ A large variety of synthetic test problems can be designed to isolate and investigate specific physical effects.

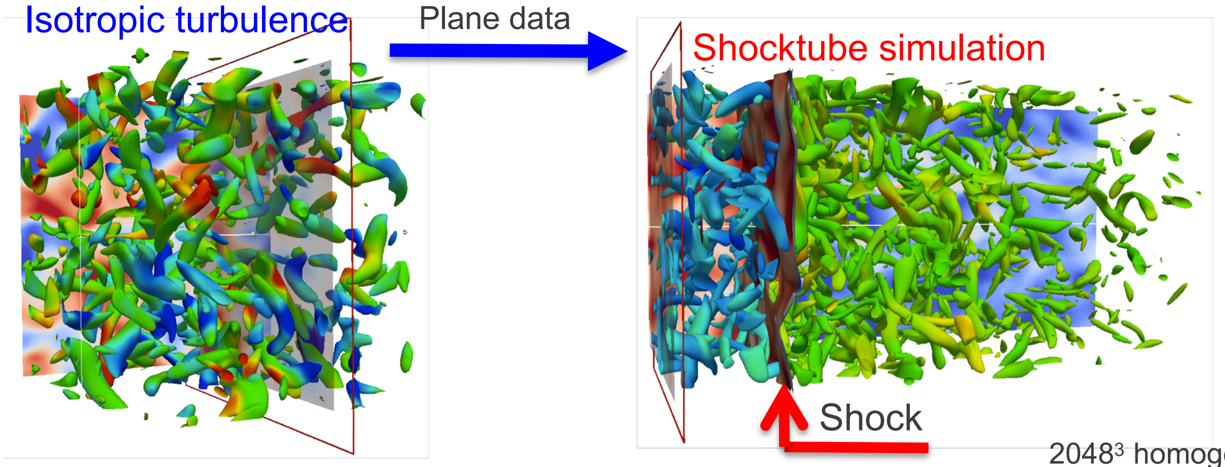
➢ *Limitations:* need the largest supercomputers available, most practical flows still out of reach.

Point of Contact: D. Livescu, CCS-2/LANL

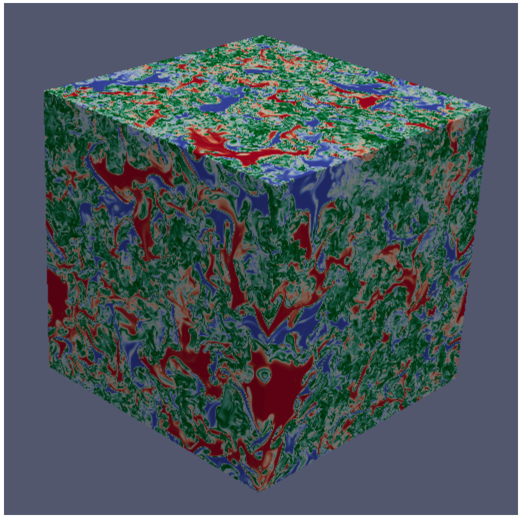
# CFDNS scales well to > 1,500,000 cores, was used to perform some of the largest turbulence simulations to date in a variety of configurations.

## More examples

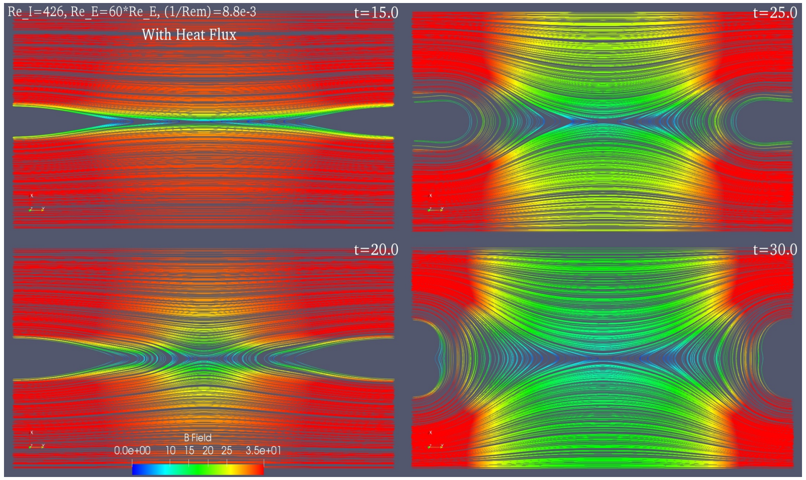
Shock-resolving DNS of shock- isotropic turbulence interaction with comprehensive coverage of the parameter space: data from $1024^3$ forced compressible isotropic turbulence is fed through the inlet of a $4096 \times 1024^2$ shock tube




$2048^3$ homogeneous buoyancy driven turbulence at high density ratio



Fully resolved magnetic reconnection with finite transport



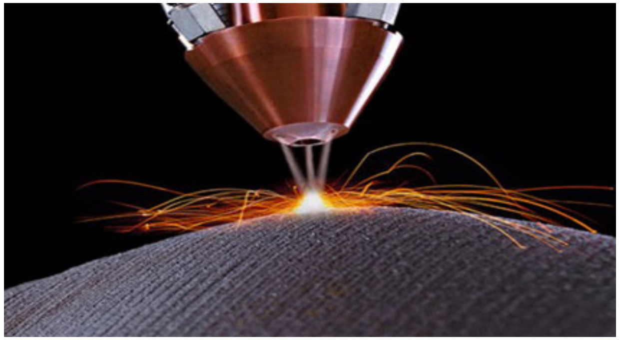

Point of Contact: D. Livescu, CCS-2/LANL

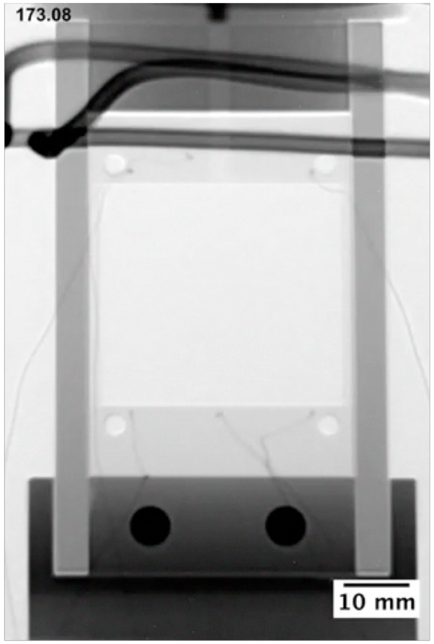
# Truchas - Metal Casting and Advanced Manufacturing

**Truchas is software for 3D physics-based modeling and simulation of manufacturing processes.**

- Primary application areas:
  - Metal casting
  - Emerging capabilities: Additive manufacturing (AM) and welding
- General multi-physics tool with wide range of possible applications
- Open source: https://gitlab.com/truchas
- Typical problem sizes < 10M cells, scaling up to several thousand cores.
- Need is for quick turn around of many modest-sized problems.

Laser powder feed AM process






Proton radiography (pRad) of casting/solidification experiment. A. Clarke, et al

Truchas is funded under the ASC Program and has been around for almost 20 years.

Point of Contact: Neil Carlson, CCS-2/LANL

# Multi-Scale Methods

# Nambe - Summary

- **Hydrodynamics codes can miss important physics**
  - EOS/Opacities/properties of mixtures
  - Kinetic effects (non-equilibrium phenomena)
  - Important and difficult to diagnose in HED experiments
- **Nambe project (collaboration with LLNL, MSU, ORNL, others) looks to examine HED problems at the atomic (molecular dynamics) and kinetic theory level, leveraging atomic level data in a multiscale way**
  - MODMD: a multiscale MD package that can compute in much larger length, time, and temperature scales than previous MD codes.
  - Stanton-Murillo derived kinetic integrated cross sections in a dense plasma regime based on ideas used in defining potentials for MD. They show remarkably good agreement with MD even in moderately coupled regimes, where previous kinetic methods break down.
  - Haack-Hauck-Murillo developed multispecies BGK-type kinetic model. This is the first entropically accurate multispecies relaxation model and directly incorporates the high fidelity Stanton-Murillo cross sections.
  - Scullard-Ellison developed an electron-ion temperature relaxation model based on the quantum Lenard-Balescu equation, which includes degenerate electron statistics and sidesteps Coulomb Logarithm ambiguities. It has been implemented into LANL (Flag) and LLNL (Ares) production codes.

# Radiation Transport

# Overview of the Transport Project

- **Delivers radiation transport capabilities software libraries:**
  - CAPSAICIN: X-ray thermal transport using finite-element methods on unstructured meshes
  - JAYENNE: X-ray thermal transport using Implicit Monte Carlo (IMC)
  - PARTISN: Neutron/gamma transport using deterministic methods on structured meshes
- **Each library is massively-parallel and runs on the latest high-performance computing hardware**
- **22 staff, (2 post-docs recently converted to staff), and 7 summer students in 2017**
- **Multidisciplinary: Nuclear and other engineering disciplines, physicists, mathematicians, computer scientists.**

Point of Contact: Jon Dahl, CCS-2/LANL

# We approximate variants of the Boltzmann Transport Equation

Linear radiation transport equation for neutrons

$$\left(\frac{1}{v}\frac{\partial}{\partial t}+\vec{\Omega}\cdot\vec{\nabla}+\Sigma_t\right)\psi(\vec{r},\hat{\Omega},E)=\int_{4\pi}\int_0^{\infty}\Sigma_s\left(\hat{\Omega}'\to\hat{\Omega},E'\to E\right)\psi' d\Omega' dE'$$

$$+\frac{\chi(E)}{k}\int_{4\pi}\int_0^{\infty}\nu\Sigma_f\psi' d\Omega' dE'+Q$$

Nonlinear radiation transport equation for thermal x-rays.

$$\frac{1}{c}\frac{\partial I}{\partial t}+\vec{\Omega}\cdot\nabla I+\sigma(\vec{r},\vec{\Omega},\nu)I(\vec{r},\vec{\Omega},\nu,t)=\sigma B(\nu,T)+\frac{Q_r}{4\pi}$$

coupled with hydrodynamic motion at temperature T

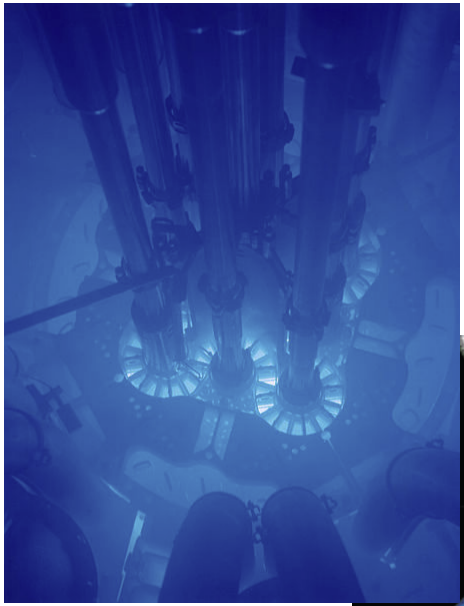
- The seven-dimensional solution domain (space+velocity+time) often results in billions, sometimes trillions, of unknowns.

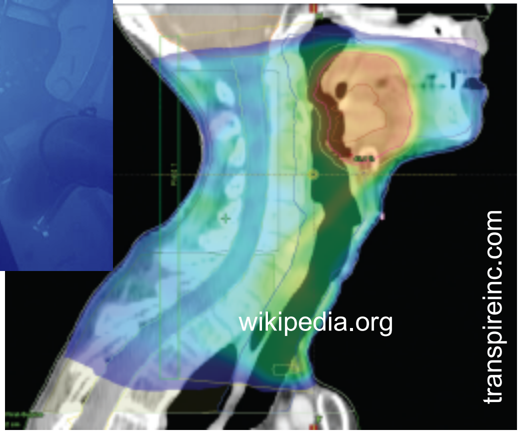
**Our radiation transport packages consume ~30% of LANL’s computational resources**

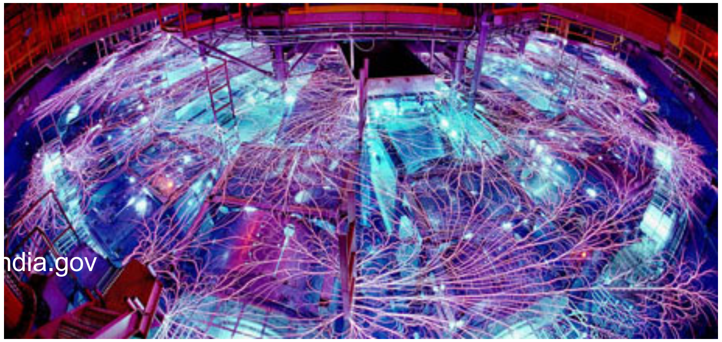
# Radiation Transport Applications

- **Neutral particle, linear transport**
  - Nuclear reactor simulations
    - Criticality (k-effective)
    - Isotope depletion
    - Shielding
  - Medical, e.g., brachytherapy
  - Oil well logging
  - Supernova explosion

- **Nonlinear transport of thermal x-rays**
  - Inertial confinement fusion
    - National Ignition Facility (Lawrence Livermore)
    - Laboratory for Laser Energetics (Rochester)
  - Astrophysics (Center for Theoretical Astrophysics, Los Alamos)
  - Z Pulsed-Power machine (Sandia)



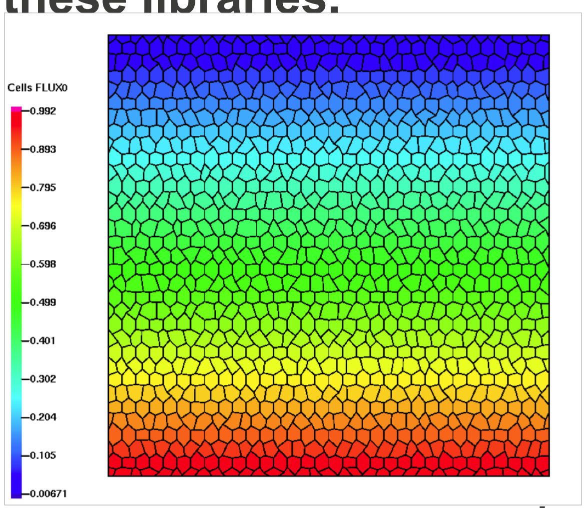




Point of Contact: Jon Dahl, CCS-2/LANL

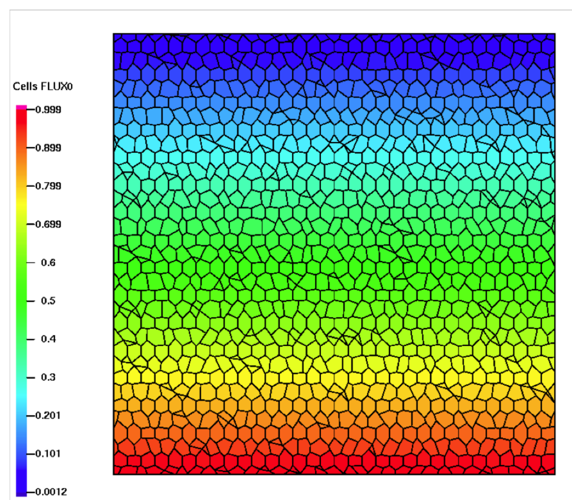
# CAPSAICIN – X-Ray Thermal Transport

**CAPSAICIN is a finite-element transport library for general mesh topologies**

- **A collection of object-oriented C++ components.**
  - 3-temperature (ion, electron, radiation), time-dependent radiative transfer
  - Steady-state radiation transport
  - Non-local tensor diffusion
- **We make heavy use of the third-party software libraries; e.g., Trilinos, ParMetis, and SuperLU_DIST. We collaborate with the developers of many of these libraries.**




non-convex mesh

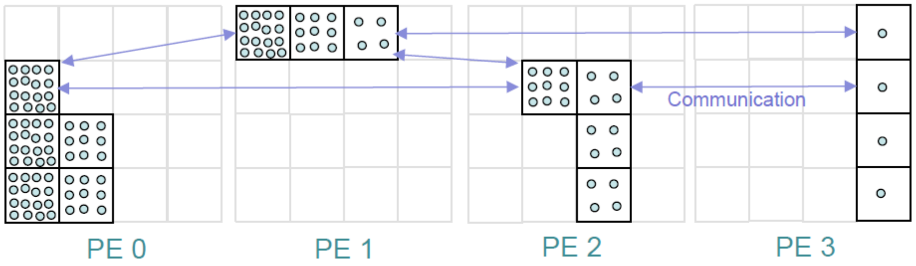


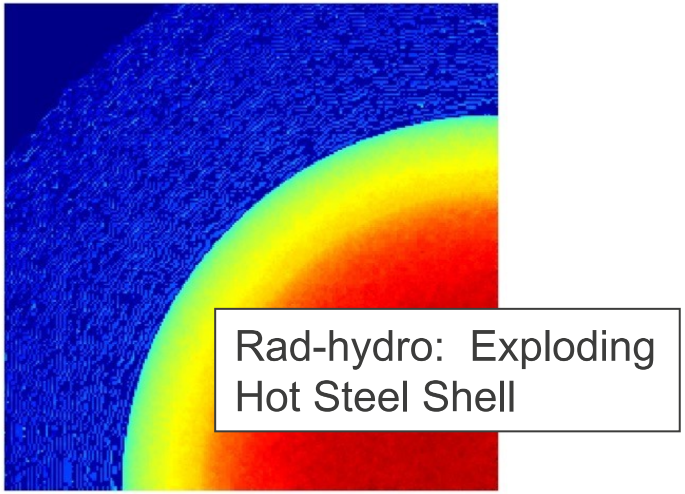

convex mesh

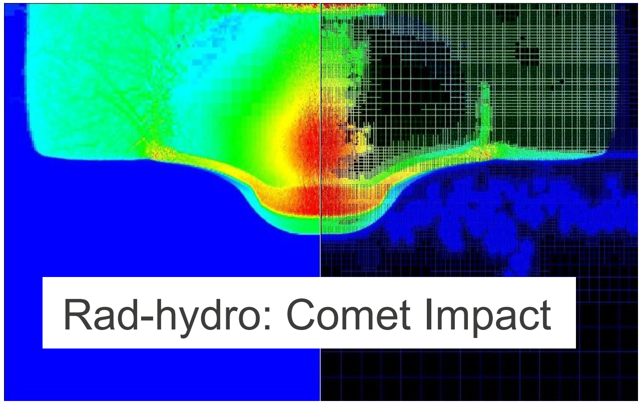
Point of Contact: Jae Chang, CCS-2/LANL

# JAYENNE: X-Ray Thermal Transport using IMC

- **Implicit Monte Carlo for x-ray transport, nonlinearly coupled with hydrodynamics for high-energy density physics simulations**
- **Object-oriented C++, sharing much code with Capsaicin (via open-source Draco library)**
- **Multiphysics: Jayenne interfaces with rad-hydro application codes**
- **Massively Parallel (MPI; MPI+X)**
  - Mesh replication or decomposition for distributing particle workload
  - Adapted to Roadrunner's IBM Cell chip, NVidia GPU, KNL, etc.
  - *Branson* mini-app (https://github.com/lanl/branson)



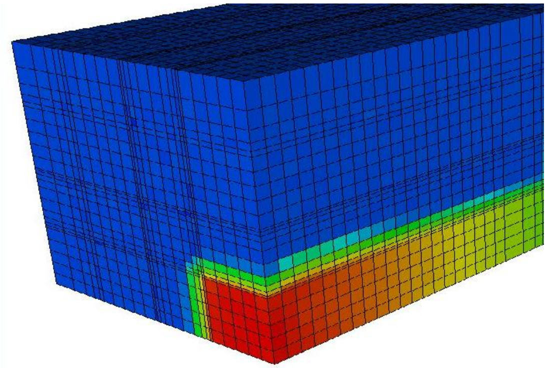



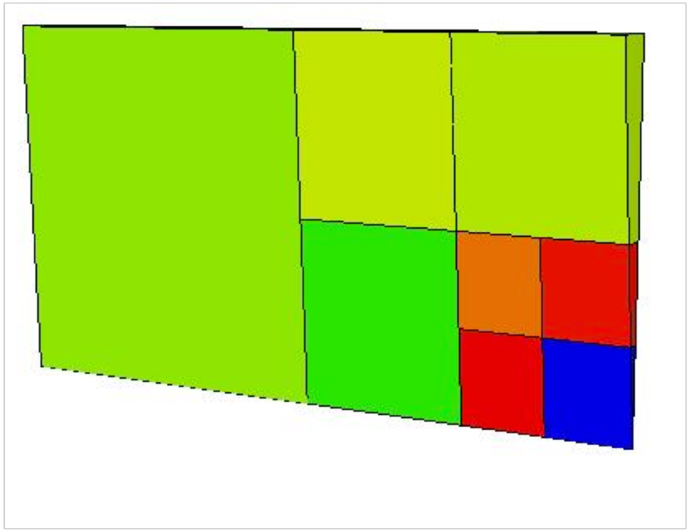

Point of Contact: Kelly Thompson, CCS-2/LANL

# PARTISN – Neutron/Gamma Deterministic Transport

**The PARTISN team covers a wide variety of research:**

- **We focus on providing computational solutions to the linear Boltzmann transport equation for neutral particles using the $S_N$ method.**
- **Our latest research includes novel material-motion discretizations and energy group treatments.**
- **We use traditional structured and block Adaptive Mesh Refinement structured meshes, for static and time-dependent problems.**





# Opportunities

# So what are the opportunities you speak of?

**Summer Schools**
- A mix of lectures and project work
- Competitive selection process
- Size is between 20 and 30 students
- Students are paired with a mentor for project work

**Graduate internships**
- Mentor led
- Less structure than the schools, no formal lecture
- Students are encouraged to attend any talks/lectures/tours that are offered.

**Post-bachelors/master**
- Generally 2-3 years between degrees

**Post-doctoral**
- Generally 2-3 years to work on research with a designated mentor
- We are always looking for good postdoc candidates from varied fields.

# Organizations that are looking for grad students with your skills

**Almost all Organization at Los Alamos hire regular summer students.**

**The following organizations hire graduate students in computational science.**

- **Computer, Computational, and Statistical Sciences Division (CCS)**
  - Computational Physics and Methods Group (CCS-2)
- **X Computational Physics Division (XCP)**
- **Theoretical Division (T)**

**Other Divisions in Science and Engineering:**

- **Physics Division (P)**
- **Materials Physics and Applications Division (MPA)**
- **Material Science and Technology Division (MST)**
- **Bioscience Division (B)**
- **Chemistry Division (C)**
- **Earth and Environmental Sciences Division (EES)**
- **Explosive Science and Shock Physics Division (M)**
- **Analytics, Intelligence and Technology Division (A)**
- **High Performance Computing Division (HPC)**
- **X Theoretical Design Division (XTD)**
- **Intelligence and Space research division (ISR)**
- **Nuclear Engineering and Nonproliferation Division (NEN)**

**To learn more search www.lanl.gov for these organizations.**

**The key is for students/professors to make connections to potential mentors in these organizations.**

# Application Materials

- **Resume/CV**
  - Include all relevant information
  - Be verbose about the research you have already done
  - Don’t just focus on your course work
- **Letter of intent**
  - Should expresses your interests and skills. Describe your previous and current research, and your strengths. Tell us what you are passionate about.
- **Transcripts**
- **Some schools require a letter of recommendation from your professor.**

**Application deadlines for most schools are in January.**

# Summer Schools

**Los Alamos National Laboratory's Information Science and Technology Institute (ISTI) (co-)sponsors a number of summer schools:**

- **Parallel Computing Research Internship**
- **Computer System, Cluster, and Networking Summer Institute**
- **Co-design School**
- **Data Science School**
- **Cyber Security School**
- **Applied Machine Learning Research Internship**
- **Computational Physics Workshop**

**http://www.lanl.gov/projects/national-security-education-center/information-science-technology/summer-schools/index.php**

**http://compphysworkshop.lanl.gov/**

# Summer Schools

- The summer schools feature a curriculum of courses, along with work on a specific research project.
- Students are paired with mentors who are LANL staff or postdocs.
- Students are encouraged to participate in the annual student symposium and poster competition.
- The organizers of the summer schools are extremely dedicated and passionate about their schools.
- LANL requires mentors to be trained.
- Reviews from students are across the board very positive about their summer school experiences.
- The application process is competitive and you should move quickly.
- The time is now to get your application materials in order.

# Summer Schools

**The two most relevant schools for CCS-2:**

- **Parallel Computing Summer Research Internship**
  - http://parallelcomputing.lanl.gov
  - Providing students with a solid foundation in modern high performance computing topics integrated with research on real problems encountered in large-scale scientific codes
  - Target student: Upper-level undergraduate, early graduate students
  - Application deadline January 26, notification mid-February

- **Computational Physics Workshop**
  - http://compphysworkshop.lanl.gov
  - This workshop seeks to bring to the Laboratory a diverse group of exceptional undergraduate and graduate students for informative, enriching lectures and to work with staff for 10 weeks on interesting, relevant projects.
  - Only for US citizens.

**See the handouts for more information.**

# Prior Year Projects Par Comp Summer School

- Asynchronous Dictionary Learning for Remote Sensing Imagery Classification, Prerna Patil (Brown), Kirtus Leyba (UNM); Mentors: Youzuo Lin (EES-17)
- Phase Transitions in Sparsely Coded Neural Networks, Jacob Carroll (Virginia Tech), Nils Carlson (NM Tech); Mentor: Garrett Kenyon (CCS-3)
- Towards Parallelized Dictionary Learning and Sparse Coding, Trokon Johnson (U of Florida), Rachel LeCover (Cornell); Mentors: Brendt Wohlberg (T-5), Cristina Garcia Cardona (CCS-3)
- Parallelization of Volume of Fluid Algorithms on Unstructured Meshes, Justin Sunu (CGU), Alonso Navarro (SDSU), Donald Kruse (UNM); Mentor: Neil Carlson (CCS-2)
- Parallel Calculation of the Radiation View Factor Matrix using Charm++, William Rosenberger (UNM); Mentor: Neil Carlson (CCS-2)
- Developing an efficient particle transport routine for the HIGRAD fluid dynamics software, Robert-Martin Short (UC Berkeley); Mentors: Eunmo Koo (EES-16), Bob Robey (XCP-2)
- Hydrodynamic Instability in Inertial Confinement Fusion, Bryan Kaiser (MIT); Mentor: Jesse Canfield (XCP-4)
- Quantum Monte Carlo with OpenMP 4.0+ for Performance Portability, Jordan Fox (SDSU), Jenny Soter (Drew University); Mentors: Stefano Gandolfi (T-2), Hai Ah Nam (CCS-2)
- Thoughtful Precision in Mini-Apps, Siddhartha Bishnu (Florida State University), Shane Fogerty (U of Rochester); Mentors: Laura Monroe (HPC-DES), Bob Robey (XCP-2)

# Prior Year Projects (Comp Phys Summer School)

- Stopping Power in Warm Dense Matter (Stopping Power)
- Lengthscale Equations for Turbulence Modeling (Lengthscale Equations)
- Predictive Models for Brittle Damage Failure of Materials (Brittle Damage)
- Monte Carlo Transport of Cosmic Rays and the Search for Dark Matter Annihilation (Cosmic Ray Propagation )
- Computational Fluid Dynamics at Scale (CFD at Scale)
- Richtmyer-Meshkov Instability for High Impedance Mismatch Imploding Shells (Imploding Shells)
- Bridging the Performance-Productivity Gap of Vectorization (Vectorize!)
- Using Monte Carlo to Determine Multiple Neutron Eigenvalues (Eigenvalues)
- Impact Modeling of Seismic Waves to Facilitate Prospecting on Other Planets (Seismic Waves)
- Cosmological Origins of Water in the Universe (Water Origins)
- Modeling Thermal Feedback in Nuclear Reactors (Thermal Feedback)
- Many-atom Modeling of Electron Photoinjection (Photoinjection)

# Summer Graduate Student Internships

- The projects listed on the prior two slides are representative of summer internship projects as well.
- The Computational Physics and Methods group (CCS-2) hires around 20 summer students each summer.
- There are many other groups that hire summer graduate interns as well.
- Early in the fiscal year (right now - October, November) a potential mentor will work with their project leader on securing funding for a summer student.
- At the same time the mentor will look for potential candidates.

**We are happy to collect your resume/CV/cover letter and distribute them to appropriate potential mentors: berndt@lanl.gov**

# Why should you work at a National Laboratory?

**The Work Environment**

- **Exciting science that is of interest to the nations security**
- **Access to unique experimental facility**
- **Access to emerging computer architectures and supper computers**
- **Competitive salaries and benefits.**

**Skills we are looking for (CCS-2 specific skills)**

- **Programing:**
  – C++, Fortran, Python, MPI, CUDA, etc…
- **High Performance Computing:**
  – Linux/Unix experience
- **Software Mangement:**
  – Continuous Integration Testing
  – Version systems (git)
  – Build systems (cmake)
- **General Knowledge:**
  – Transport, Multiphysics, Hydrodynamics, Numerical and Applied Mathematics, Simulation and Analysis, Climate Modeling, Computer Science, etc…

# Caveats

- We do hire foreign national (FN) summer students, and so do many other groups in at LANL.
- Paperwork and approvals for FNs take more time (between 30 and 90 days).
- We know how to navigate the the required approvals.
- FN students are typically hired under the F-1 visa curricular practical training program. They receive the same pay as everyone else.
- One of the summer schools only hires US citizens.
- Housing in Los Alamos gets very tight in the summer. This is another reason not to delay.
- Office space gets very tight in the summer and we sometimes have to turn down students due to lack of space → apply early!

Questions

cleveland@lanl.gov